

ME240 Flow Bench

Operating Instructions



Overview:

The flow bench consists of a system to pump water through a changeable transducer, a water mass measurement system and a pressure transducer to read differential pressure.

Pumping system:

The pump system is a fixed speed pump that draws water from a stationary tank. Water is supplied to the transducer through a vertical line that contains a paddlewheel flow element to indicate approximate volume flow. Water is supplied to the changeable transducer and flow is throttled after the transducer with two valves located behind the electronics box as indicated in the following figure.



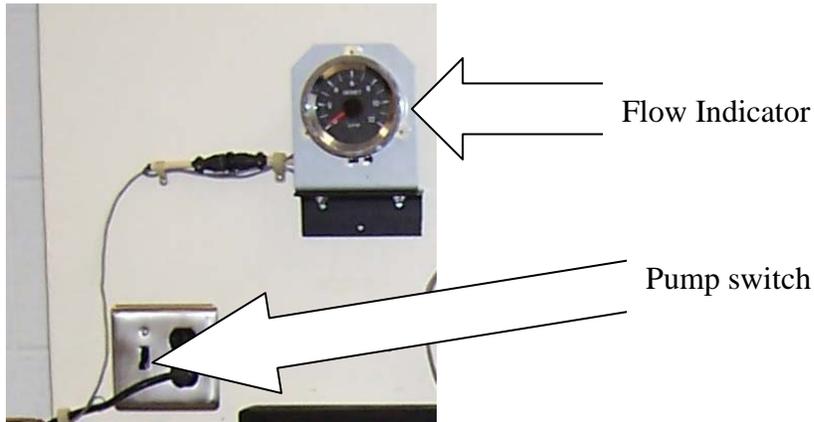
There are two valves in this location. A black handle valve and a red handle valve. These provide a fine and course flow control respectively. Both valves provide full shut-off and are plumbed in parallel to allow both valves to be used at the same time, or only one valve is chosen. The red handled valve contains a rubber seat, and as such tends to do a poor job at low flow control (less than 2GPM) For low flows the black handle valve should be used. Once the flow this valve can handle is exceeded, you will have to use a combination of both valves.

Once flow has passed these control valves, the water is discharged into a weigh tank below the table. The tank is resting on a scale to allow weighing of the mass of water,

Dump Valve



and is fitted with a dump valve and an overflow tube. Closing the dump valve allows water to collect in the tank for weighing. The overflow is intended to prevent the tank from overflowing on the floor, however at very high flow rates it is insufficient to keep up and care must be taken to not overflow the tank. The Pump is controlled by a switch on the left side of the system, and a water flow indicator gives an approximate volume flow indication for reference purposes. This meter is NOT a mass flow meter.



Transducers:

A number of transducers have been provided for the experiment. These include a nozzle, an orifice, a venturi, a Nutating disk, a rotameter, two paddlewheel meters in different size feed lines (1/2" and 1") and a vortex shedding meter. All of these meters are installed into the water flow with a cam lock connector system. A number of these also have pressure taps to allow the connection of the water pressure transducer. These connections are keyed to allow the pressure lines to connect in only one way and with the exception of the rotameter, the taps are not the shut off variety. This means that if you turn on the pump without the pressure lines connected, you can expect the garden hose effect. The two paddlewheel meters are identical, with the exception of the feed line that they are inserted into. Both of these meters are set up to connect to a frequency counter provided. The Vortex shedding meter is a 4-20ma loop powered transducer. This means that you will need to connect it to the power supply connections on the front of the electronics panel and to a multimeter to read the current. Be careful not to reverse the power connections as damage to the meter may result.

Electronics box:

The electronics box provides a number of indicators. The indicators of concern for this experiment are the water temperature and the differential pressure meters. The other two meters in the system are unused for this lab. In addition a frequency counter and a multimeter will be provided.

Weigh Tank Operation:

The weigh tank system consists of a tank with valve, and a scale. The scale is a tip balance scale with a weight pan with a 100:1 multiplier. The scale also has a slide weight to balance the tank.



The slide weight may be moved to balance the system to a negative weight (arm in the down position). The valve is then closed on the tank. The arm is watched for movement, and as the arm trips from the low position to the high position, the stopwatch is started. An appropriate mass is added to the weight pan, moving the arm back to the low position. The stop watch is stopped when the arm again moves to the upper position.

At higher flow rates the tip process is quite fast, and accurate. At very low flow rates this process can be quite slow. To aid in accurately starting and stopping the stop watch, a pointer is provided as a reference point so that the watch can be triggered at the same point in the process for both start and stop operations.

Weights are provided that weight from 5 to 200 Grams. These translate to water weight in the tank of 500 to 20K grams. In general a mass should be selected that allows for a time between 30 seconds and a minute of flow.

Operational Notes:

- 1) If the balance weight is moved to its maximum location (near the pan) a 20Kg mass in the tank will cause an overflow.
- 2) At higher flow rates the pump may need to be shut off to allow the tank to empty adequately.
- 3) As the flow is not always fully stable, and has a tendency to drift lower with time, it is a good practice to take a reading on your instrument (pressure, current, frequency, etc) at the beginning and end of the weigh period, and average these readings for a more accurate value.
- 4) Differential pressure is measured in inches of water. The transducer has been placed with the center of the transducer on the flow line of the pipe, however, transducers of such low ranges are particularly bad for variations due to positions of the lines, amount of water / air in the lines etc. It is good practice, to install the flow element, flow water at a reasonable rate to purge air from the system and then to fully close both flow valves to “deadhead” the flow. Once the pressure settles, a reading should be taken and used for the zero reading until the flow element is changed or lines are removed or moved.